JPL NO. 9950-824

DRL 175

DOE/JPL-956205-83/3
Distribution Category UC-63

Quarterly Technical Progress Report

No. 6329-9

on the

DEVELOPMENT OF METALLIZATION PROCESS

FSA Project, Cell and Module Formation Research Area

For the Period Ending

December 31, 1982

Contract 956205

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April 1983

The JPL Flat Plate Solar Array Project is sponsored by the U.S. Department of Energy and forms part of the Solar Photovoltaic Conversion Program to initiate a major effort toward the development of low-cost solar arrays. This work was performed for the Jet Propulsion Laboratory, California Institute of Technology by agreement between NASA and DOE.

ABSTRACT/SUMMARY

Solar cells have been produced using a Mo/Sn/TiH screen printed paste with a lead/borosilicate frit that are electrically comparable to control silver cells. The process is currently unsuccessful because the soldering of interconnects to these cells has proved difficult. Future work will investigate using CO instead of H_2 as the reducing gas and putting an ITO coating on the cell prior to metallization.

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Section 1.0

INTRODUCTION

The objective of this contract is the optimization, evaluation, and demonstration of a novel metallization applied by a screen printing process. The process will be evaluated on both CZ and non-CZ silicon wafers.

Section 2.0

TECHNICAL DISCUSSION

In order to improve upon adhesion and solderability another paste type was procured from Thick Film Systems. This was similar to the type A paste with a frit added. The frit used was a Pb/boro-silicate glass. The table below shows the various compositions:

Type	Mo	Ti	Sn	Frit
A DP-E570	19.5	80.0	0.5	0
B DP-E571	50.0	49.5	0.5	0
C DP-E572	70.0	29.5	0.5	0
D DP-E573	49.0	49.0	2.0	0
E DP-E574	48.0	48.0	4.0	0
F DP-F503	19.5	80.0	0.5	5.0

The F paste showed better adhesion but was still not solderable. Inclusion of the frit did not decrease shunt resistance.

A series of experiments was undertaken to determine if the method of cleaning prior to screen printing had any effect on adhesion. Table 1 shows a variety of the cleaning procedures that were tried. Procedure A is our baseline procedure which is used on silver printed cells. All cells showed poor adhesion of the Mo/Sn metallization regardless of the cleaning procedure. The D procedure worked well with silver paste controls and will be used as the standard procedure.

Table 1

CLEANING PROCEDURES

A		B		C		D	
10% HCl	1 min.	10% HCl	1 min.	10% HCl	1 min.	85°C $H_2O/NH_3/H_2O_2$	30 sec.
H_2O	Rinse	H_2O	Rinse	H_2O	Rinse	H_2O	Rinse
10% HF	1 min.	10% HF	1 min.	10% HF	1 min.		
H_2O	Rinse	H_2O	Rinse	H_2O	Rinse		
50% AcOH	1 min.	$H_2O/NH_3/H_2O_2$	30 sec.				
Hot H_2O	Rinse	H_2O	Rinse				
Acetone	2 min.						
MeOH	2 min.						
Hot H_2O	2 min.						
H_2O,N_2	5 min.						

Twenty-five cells were produced using the Type F paste containing the lead borosilicate frit. All cells produced were electrically equivalent to silver controls. These cells were fired in air at 18"/min. and 600°C then reduced in H_2 for 90 sec. at 650°C. This sequence produced cells which passed a tape pull test ∿50% of the time.

The cells that passed tape pull were used for soldering experiments. Interconnects were soldered to cells using conventional techniques with tip temperatures varying from 550 to 750°C. No bondings were successful.

Interconnects were then soldered using a heated substrate; these attempts were also unsuccessful. Finally, ultrasonic soldering was attempted but was unsuccessful.

It was concluded that these pastes reduced in hydrogen would not work. It has been theorized that the hydrogen in some way interferes with the bonding to the Si surface. Carbon monoxide has been ordered to replace hydrogen as the reducing agent.

Cells have been sent out to receive indium/tin oxide coating. An 800Å layer will serve as an AR coating and possibly allow the successful bonding of paste to the cell.

Section 3.0

CONCLUSIONS AND RECOMMENDATIONS

Work will continue on solving the adhesion problem between the pastes and silicon which preclude the successful solder of interconnects to the cell.

Section 4.0

ACTIVITIES PROJECTION

Weak adhesion between the metallization and the silicon continues to be a major problem. Soldering techniques proved unsuccessful. ITO coatings and CO firings will be investigated in the next quarter. A Milestone and Delivery Schedule is shown on the following page.

SPECTROLAB
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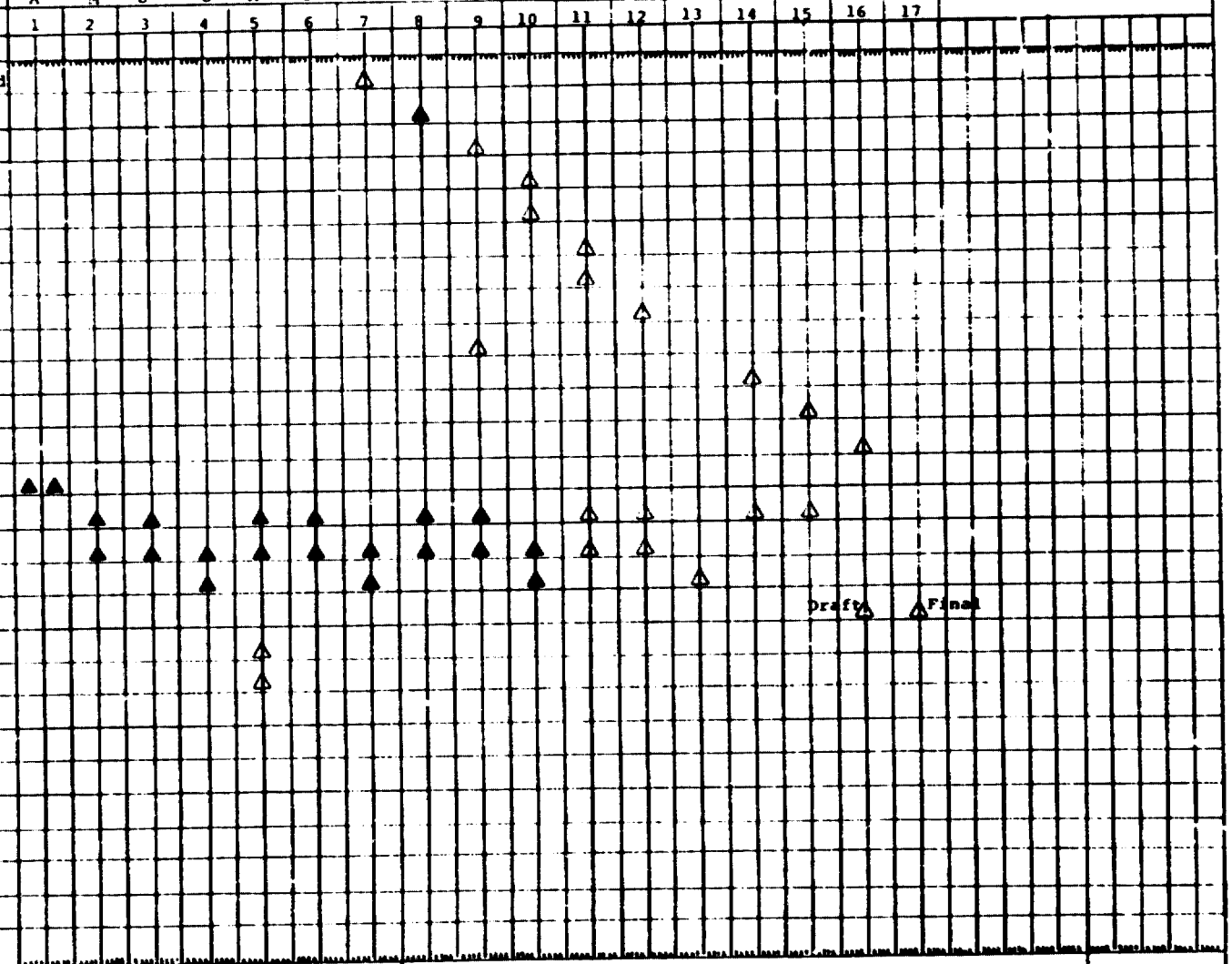
MILESTONE CHART AND DELIVERY SCHEDULE

SHEET 1 OF 1
DATE 11/24/82
REVISION 1



ITEM OR TASK	DESCRIPTION
	Final Mo/Sn Metallization Selected
	Prototype Cells Fabricated
	Front Soldering Process Finalized
	Front Demonstration Cells Fabricated
	ITO on Metal Initial
	Prototype Cells ITO on Metal
	Metal on ITO Initial
	Prototype Metal on ITO Cells
	Initiate Metallization Tests
	Finish Metallization Tests
	Metallization System on WEB
	Metallization System on Semix
	Program Plan
	Monthly - Technical
	Monthly - Financial
	Quarterly - Technical
	Final
	Documentation Specification
	Economic Evaluation

LEGEND

NOTES

CUSTOMER JPL

PROGRAM METALLIZATION PROCESS

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